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CROSS-COUNTRY CO-MOVEMENT BETWEEN BITCOIN EXCHANGES: A CULTURAL ANALYSIS

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Abstract

This paper analyses co-movement between Bitcoin exchanges in 34 major countries around the world and the US (the global benchmark) over the period January 24, 2011 - January 7, 2019. More specifically, we run IV regressions to investigate the importance of cultural factors (such as tightness, individualism, trust and risk-taking) following an earlier study by Eun et al. (2015) which had shed light on their importance to explain stock co-movement within individual countries. The results suggest that markets in tighter, more individualistic, trustful and risk-taking societies are more tightly linked to the US one. Further, it appears that culturally looser, collectivistic, trustful and risk-taking countries are more likely to shut down their Bitcoin exchanges compared to other countries. These findings confirm our priors.

JEL Classification: G15, C36

Keywords: Bitcoin exchanges, cultural analysis, co-movement

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1. Introduction

Cryptocurrency markets have been growing very rapidly in recent years; they include 4600 different types of cryptocurrencies (according to coinmarketcap.com, 11 December 2019), Bitcoin being the most popular one and representing about 66.6% of the total market capitalization. However, research on the systematic variations in their return structure is relatively limited. This paper analyses the cultural drivers of co-movements between Bitcoin exchanges in 34 major countries around the world and the US (which is taken to be the global benchmark) over the period January 24, 2011 - January 7, 2019. In particular, we run IV regressions to investigate the importance of cultural factors (such as tightness, individualism, trust and risk-taking) following an earlier study by Eun et al. (2015) which had shed light on their importance to explain stock co-movement within individual countries.

Previous studies on cryptocurrencies have focused on their economic implications (e.g., Böhme et al., 2015; Dwyer, 2015; Harvey 2016; Raskin and Yermack 2016; Bariviera et al., 2017; Biais et al., 2018; Schilling and Uhlig 2018), returns and risk (e.g., Balciar et al., 2017; Liu et al., 2018), market efficiency (e.g., Urquhart, 2016; Bariviera, 2017; Nadarajah and Chu, 2017), hedging properties (e.g., Dyhrberg 2016a, 2016b; Baur et al., 2018; Bouri et al., 2017a, 2017b, 2017c), illegal activities (Foley et al., 2018, Li et al., 2018; Gandal et al., 2018; Griffin and Shams, 2018), initial coin offerings (Kostovetsky and Benedetti. 2018; Howell et al., 2018; Lee et al., 2018b; Li and Mann, 2018; Malinova and Park, 2017) and so on. More recently, a few papers have analysed cryptocurrency co-movement (or connectedness). In particular, Corbet et al. (2018) and Lee et al. (2018a) find weak linkages between cryptocurrencies and other traditional assets, which implies that the former may offer diversification benefits to investors, especially in the short run. Ciaian et al. (2017) report that the prices of Bitcoin and other cryptocurrencies are independent of each other. Using a bivariate diagonal BEKK model, Katsiampa (2019) finds that volatility co-movements between Bitcoin and Ether are significant and responsive to major news. Shams (2019) is the first to use a pairwise 'connectivity' measure based on the Manhattan distance between the share of trading volumes of cryptocurrencies across different exchanges to explain their co-movements. However, none of the extant literature investigates the effects of cultural variables on the co-movements between Bitcoin exchanges internationally. To the best of our knowledge, this paper is the first to analyse this issue.

Specifically, we focus on four cultural dimensions (i.e., tightness-looseness, individualism-collectivism, trust and risk-taking) which we regard as highly relevant to Bitcoin price co-movement using the US as a global benchmark. According to Gelfand et al. (2006), individuals have a more (less) homogeneous behaviour and demonstrate a lower (higher) degree of variation in countries with a tighter (looser) culture, this being an external constraint on individual behaviour. Eun et al. (2015) show that stock price co-move more in culturally tight countries. Thus, we also expect higher Bitcoin prices co-movement vis-à-vis the US in the case of such countries. We then consider the effects on Bitcoin price co-movement of individualism versus collectivism, these being an individual's internal attributes (Eun et al., 2015). Individualistic agents tend to have an analytic thinking style and to use logic to explain and predict an object's behaviour (Choi and Nisbett, 2000; Nisbett et al., 2001; Eun et al., 2015). Since the US Bitcoin exchanges have the longest history, the largest worldwide impact and the lowest probability of shutdowns, investors with a logical mindset should follow US prices instead of domestic ones. Therefore, we expect a higher degree of Bitcoin price co-movement in the case of more individualistic cultures. As for the impact of trust, Liu (2016) finds that generalised trust, which reflects how an agent looks upon other individuals as a whole, increases cross-country stock market correlation. Thus, we expect countries with a higher degree of trust to exhibit more co-movement vis-à-vis the US, our global benchmark. Moreover, risk-averse Bitcoin investors should be more inclined to trade on domestic exchanges for which it is easier to gain access and relevant information, whilst risk-loving investors should trade Bitcoin on the basis of the US Bitcoin price rather than the domestic ones; consequently, more co-movement should occur in the latter case.

We also expect the underlying culture to affect Bitcoin exchange shutdowns. As already mentioned, tightness is an external constraint on individual behaviour requiring agents to follow social norms and is characterised by lower tolerance for deviant behaviour (Gelfand et al., 2006); a Bitcoin exchange shutdown could be regarded as an example of the latter since it can cause significant disruption to financial markets. Therefore, we expect Bitcoin shutdowns to be less likely in the case of countries with a tighter culture. As for the impact of individualism, this being an internal attribute of a person who is more likely to exhibit stronger analytic skills (Choi and Nisbett, 2000; Nisbett et al., 2001; Eun et al., 2015), this should result in a lower probability of shutdowns since individualist agents should be more eager to trade on the Bitcoin markets and more likely to understand the chaos shutdowns could bring about. Further, in countries with a trusting culture investors should be more vulnerable to Bitcoin trading which is highly speculative, and therefore shutdowns should be more likely. Finally, they should occur more frequently in more risk-taking cultures (with the possibility of massive losses resulting from speculation).

Our results suggest that indeed markets in tighter, more individualistic, trustful and risk-taking societies are more tightly linked to the US one. In particular, it appears that, in the presence of a higher level of conscientiousness and social stability resulting from a tighter (as opposed to looser) culture, investor behaviour leads to cross-country Bitcoin trading co-movement (the US being the global benchmark), consistently with Eun et al.'s (2015) findings on the effects of a tight culture on stock co-movements. Interestingly, whilst individualism (as opposed to collectivism) had been found by Eun et al. (2015) to decrease stock co-movement within a country, we find that it has a positive impact on cross-country co-movement vis-à-vis the US, with investors following the US Bitcoin markets which are considered more reliable for the reasons already mentioned. We also find that investors in countries with a more trusting culture follow the US market (the global benchmark) despite its being a foreign one. Similarly, risk-loving investors tend to trade Bitcoin following the US market more than the local ones. Bitcoin trading is a highly speculative activity and most of the time there is strong co-movement between the Bitcoin exchanges in different countries. Therefore, Bitcoin investors tend to be more interested in the US Bitcoin markets which have a significant market share with less restrictions to trade compared to other markets.

Next we extend our cultural analysis to Bitcoin exchange shutdowns. We find that countries with looser, more collectivist, trustful and risk-taking societies are more likely to shut down their Bitcoin exchanges compared to others. A Bitcoin exchange shutdown causes much greater uncertainty for investors than Bitcoin trading itself. Therefore, countries with a tighter culture are reluctant to shut down their Bitcoin exchanges. Countries with a more individualistic culture tend to have more analytically skilled investors who prefer Bitcoin exchanges to remain open to give them the opportunity to increase their wealth using their skills. We show that trust also increases the probability of Bitcoin exchange shutdowns. Less trustful individuals are less likely to engage in Bitcoin trading, just as in the case of stock markets (see Guiso et al., 2008). Therefore, a Bitcoin exchange could be shut down owing to the fear of excessive speculative

Bitcoin trading caused by an increase in trust. Further, more risk-taking behaviour increases Bitcoin exchange shutdowns to prevent further speculative losses for investors.

The layout of the paper is as follows. Section 2 outlines the methodology. Section 3 describes the data and presents the empirical findings. Section 4 offers some concluding remarks.

2. Methodology

We use the R^2 from the expanded market model by Morck et al. (2000) and Jin and Myers (2006) to measure Bitcoin price co-movement across countries. The specification is the following:

$$
\begin{aligned}
r_{i,t} = \alpha_i &+ \beta_{1,i}\left[r_{US,t} + EX_{i,t}\right] + \beta_{2,i}\left[r_{US,t-1} + EX_{i,t-1}\right] \\
&+\beta_{3,i}\left[r_{US,t-2} + EX_{i,t-2}\right] + \beta_{4,i}\left[r_{US,t+1} + EX_{i,t+1}\right] \\
&+\beta_{5,i}\left[r_{US,t+2} + EX_{i,t+2}\right] + \varepsilon_{i,t} \qquad (1)
\end{aligned}
$$

where

$r_{i,t}$ is the weekly Bitcoin return of country *i* in week *t* of a year, and $r_{US,t} + EX_{i,t}$ is the US market return (a proxy for the global market) adjusted for the change in the exchange rate of country *i* vis-à-vis the US dollar. We choose the US Bitcoin market as a global benchmark since it has the longest history, no Bitcoin exchanges shutdown decisions, and relatively high trading volumes; in addition, the US dollar is the most widely supported national currency on exchanges (Hileman and Rauchs, 2017).

Following Dimson (1979), we correct for non-synchronous trading by including two lead and lag terms for the US market indices. In most countries, there exists only a small number of Bitcoin exchanges with very similar Bitcoin prices most of the time. Thus, we use only one representative Bitcoin price and volume for each country defined as the average value in each week *t* across the Bitcoin exchanges. Therefore, unlike Morck et al. (2000) and Jin and Myers (2006), we analyse price co-movements across countries but not within each country. More specifically, we do not include the weekly market return of country *i* in week *t* as in their model since we only consider one Bitcoin return for each country.

We examine the relationship between culture and Bitcoin price co-movement across countries using a similar set of variables to Morek et al. (2000), Jin and Myers (2006) and Eun et al. (2015). We also add country-specific variables including Bitcoin returns (Bit_R), trading volumes (Bit_V), geometric capital distance between a country and the US, and international Internet bandwidth (kb/s) per Internet user (bandwidth), as well as economic control variables, specifically GDP per capita (GDP) and GDP growth volatility (GDP_gvol), which are lagged one year to avoid hindsight bias. Finally, we include the global hash rate of blockchain (Hash_rate). Note that we take the natural logarithm (ln) of the Bit_V, GDP, GDP_gvol and Hash_rate variables to deal with the scaling issue.

We then run an instrumental variable (IV) regression with Tight, Indiv and Trust as endogenous variables and country-specific indices for corruption (Corrupt), inefficient government bureaucracy (Govbur) and religion (Religion) as instruments. Since the number of endogenous variables and instruments is the same, the IV regression is just identified. It takes the following form:

$$
\begin{aligned}
R_i^2 = {} & \alpha + \beta_1 Bit\_R_i + \beta_2 \ln(Bit\_V_i) + \beta_3 Tight_i + \beta_4 Indiv_i + \beta_5 Trust_i + \beta_6 Risk\_taking_i \\
& + \beta_7 ln(GDP_i) + \beta_8 GDP\_gvol_i + \beta_9 ln(Gendist_i) + \beta_{10} Bandwith_i \\
& + \beta_{11} Internet\_users_i + \beta_{12} ln(Hash\_rate) + \varepsilon_i \qquad (2)
\end{aligned}
$$

where the variables are defined as specified above and the subscript *i* indicates a country. R_i^2 (the goodness-of-fit from equation (1)) is our co-movement measure. Since it is bounded within the interval [0,1], following Morck et al. (2000) and Eun et al. (2015) we also use the log-transformed R^2 as a robustness check:

$$\text{Log-transformed } R_i^2 = Tr(R_i^2) = Ln(\frac{R_i^2}{1-R_i^2}) \tag{3}$$

We then extend the analysis to examine the effects of the cultural variables on the Bitcoin exchange shutdowns; specifically, we estimate IV logit regressions with a Bitcoin exchange shutdown binary variable (*Shut_down*) which is equal to one if a country shuts down its Bitcoin exchanges within our sample period and zero otherwise.

$$\begin{aligned} Shut\_down_i = {} & \alpha + \beta_1 R_i^2 + \beta_2 Bit\_R_i + \beta_3 \ln(Bit\_V_i) + \beta_4 Tight_i + \beta_5 Indiv_i + \beta_6 Trust_i + \\ & \beta_7 Risk\_taking_i + \beta_8 ln(GDP_i) + \beta_9 GDP\_gvol_i + \beta_{10} ln(Gendist_i) + \\ & \beta_{11} Bandwith_i + \beta_{12} Internet\_users_i + \beta_{13} ln(Hash\_rate_i) + \\ & \beta_{14} Mathedu_i + \varepsilon_i \end{aligned} \tag{4}$$

for country *i*. In equation (4), Tight, Indiv and Trust are the endogenous variables and Corrupt, Govbur and Religion the respective instruments (the same as in the IV regression given by equation (2)). We also include our co-movement measure R_i^2 in the IV logit regression, and replace it with $Tr(R_i^2)$ as a robustness check. In addition, the maths education level of a country (*Mathedu*) is also included as an explanatory variable.

3. Data and empirical results

3.1. Data description

The data on weekly Bitcoin prices and trading volumes are obtained from https://data.bitcoinity.org. The sample period goes from January 24, 2011 to January 7, 2019. R^2 is the co-movement measure we use following Morck et al. (2000) and Jin and Myers (2006). $Tr(R^2)$ is the logistic transformation applied to R^2 following Morck, Yeung, and Yu (2000). Bit_R stands for Bitcoin's daily log returns. ln(Bit_V) is the natural logarithm of Bitcoin volume. Tight is the country-specific tightness-looseness score from Gelfand et al.'s (2011) data set. A tight (loose) culture in a country has strong (weak) social norms and low (high) tolerance for deviant behaviour (Gelfand et al., 2011; Eun et al., 2015). Indiv is the country-specific individualism-collectivism score collected from the Hofstede's (2001) data set. It is based on the extent to which people are integrated into groups and the degree to which they focus on their internal attributes to differentiate themselves from others (Hofstede, 1980, 2001; Eun et al., 2015). Thus, people from individualistic culture tend to have more analytic skills and use logic to explain and predict an object's behaviour (Choi and Nisbett, 2000; Nisbett et al., 2001; Eun et al., 2015). Trust and Risk_taking are country-specific trust and risk-taking behaviour measures, respectively, collected from the World Values Survey (WVS). Higher values for Trust and Risk_taking indicate a more trustworthy environment and more risk-taking behaviour, respectively. The four cultural variables Tight, Indiv, Trust and Risk_taking are the main ones in our analysis.

Corrupt and Govbur are the corruption and inefficient government bureaucracy indices, respectively, for each country collected from the Global Competitiveness Report. We use Corrupt as an instrument for the Tight cultural variable since a corrupted environment can affect the generally accepted social norms and tolerance level of deviant behaviour in a country. We then use Govbur as an instrument for our Indiv cultural dimension. According to Weber (1946), bureaucracy is a social organisation formed to manage effectively large populations by following uniform rules and procedures by means of a hierarchical system (Schiller, M). Therefore, the degree of (in)efficiency of a government bureaucracy (Govbur) can endogenously affect the individualism-collectivism culture of a country. ln(GDP) and GDP_gvol are the natural logarithm of Gross Domestic Product (GDP) and GDP growth volatility, respectively, in each country; the source is the World Bank database.

Internet_users, bandwidth and ln(Hash_rate) are collected from the Global Competitiveness Report. Internet_users and bandwidth are the country-wise percentage of total population using Internet and the Internet bandwidth kb/s/user, respectively. ln(Hash_rate) is the natural logarithm of the block chain's hash rate. The religion variable is collected from the Central Intelligence Agency (CIA) World Factbook; it is a binary variable equal to one if the country's main religion is Christianity (including both Catholic and Protestant) as in the US, the global benchmark, and zero otherwise. In the US Protestants (46.5%) and Catholics (20.8%) are the two main religious groups, and we assume that investors' trust increases if their religion is aligned with the US. Therefore, we use Religion as our instrument for trust. ln(Gendist) is the natural logarithm of the geographical distance (in kilometers) between a country's capital and the US capital cities; the source is the Centre d'Études Prospectives et d'Informations Internationales (CEPII) database. Mathedu is a Quality of math and science education index collected from the Global Competitiveness Report. Shutdown is a binary variable equal to one if a country has experienced a Bitcoin exchange shutdown during our sample period and zero otherwise.

Table 1 reports some summary statistics for the variables included in the model. We find that the cryptocurrency co-movement measure R^2 is generally high (Mean = 0.90) and left-skewed, with more clustering in the high value region (the same holds for its logistic transformation $Tr(R^2)$). R^2 is much less volatile (Std = 0.07) than $Tr(R^2)$ (Std = 0.64). Bitcoin returns are clustered (slightly more in the case of low values), while trading volumes tend to be high and left-skewed. We also find that the countries in our sample tend to have cultures more clustered towards relatively tighter (Tight), individualistic (Indiv), less trustful (Trust), more risk-taking (Risk_taking), less corrupted (Corrupt) and more inefficient government bureaucracy (Govbur) as indicated by the skewness of each of these variables in turn.

Most countries in our sample have high economic growth ln(GDP) while its volatility GDP_gvol is not clustered. A small number of countries have fast Internet bandwidth kb/s/user (Bandwidth) compared to others as indicated by the corresponding mean and median values. By contrast, the percentage of Internet users per country (Internet_users) is high in all countries in our sample. The hashrate (ln(Hash_rate)) is also relatively high in most cases. Most of the countries examined are aligned with the US in terms of their dominant religion (Christianity - Protestant and Catholic), the Religion variable being left-skewed. In addition, they tend to be relatively far from the US capital cities as indicated by the left-skewed distribution of ln(Gendist). The mathematics education level (Mathedu) is generally low. Bitcoin exchange shutdowns tend to be rare, the binary variable Shutdown being right-skewed. Table 2 shows the correlation coefficients between the variables and suggests that there is no multicollinearity between the regressors.

[Insert Table 1 Here]

[Insert Table 2 Here]

3.2. Empirical results

3.2.1. Cultural effects on cross-country co-movement between Bitcoin returns

Table 3 presents the regression results using R^2 and $Tr(R^2)$ in turn as the dependent variables and both ordinary least squares (OLS) and instrumental variable (IV) methods in each case. These can be summarised as follows. The culture variables Tight and Indiv have a positive effect on the co-movement of Bitcoin exchanges with the global benchmark, i.e. the US Bitcoin market. According to Harrington and Gelfand (2014), tightness is associated with a higher level of conscientiousness, social stability, incarceration rates, discrimination and inequality, and lower openness, homeliness, social disorganization, drug or alcohol use, creativity and happiness, in comparison to looseness. Our results indicate that Bitcoin co-movement with the US increases with tightness, i.e. it is higher in the case of countries with a higher level of conscientiousness and social stability. This suggests that in such countries investors tend to be more sophisticated than elsewhere, since they design their investment strategies on the basis of the global outlook as well as the local Bitcoin market situation; they typically have more individualistic characteristic and analytical skills, which results in a better understanding of financial markets, and tend to follow the US Bitcoin market since this is the global benchmark. Otherwise, they follow instead domestic Bitcoin prices which are easier to access and understand, although these are in fact mainly affected by the US ones.

The finding that Bitcoin co-movement is higher in the case of more individualistic cultures is in contrast to the conclusions of Eun et al. (2015), who found the opposite when analysing stock co-movements within each country rather than cross-country co-movements as in the present study. As for the positive coefficient on the Trust variable, a plausible interpretation is that it is due to the fact that the US market is perceived as more reliable, as already pointed out, and it has relatively large trading volumes compared to other countries.

Finally, there is also a positive effect of risk-taking on co-movement. In other words, more risk-taking Bitcoin investors follow the global benchmark rather than domestic prices despite the latter being more easily accessible for them.

Bitcoin investment is a highly speculative activity, the co-movement between Bitcoin exchanges being high most of the time (the mean of R^2 is 0.9 in Table 1). This suggests that risk-loving Bitcoin investors tend to increase their speculative activities following movements in US Bitcoin prices. Similarly, the average Bitcoin price co-movement being relatively high across the globe, US Bitcoin price movements lead to higher trading volumes (ln(Bit_V)).

Concerning the other variables, we find that wealthier (ln(GDP)) and more stable (GDP_gvol) countries tend to have greater Bitcoin price co-movement vis-à-vis the US than less developed ones whose investors exhibit 'home bias' (Coeurdacier and Rey, 2012), being more interested in the local Bitcoin price indices. We also find that Bitcoin prices in countries geographically more distant from the US, as indicated by ln(Gendist), tend to comove less. Possible reasons for these patterns are informational advantages and behavioural preferences for familiarity which are also found to account for stock market correlations (Eckel et al., 2011). Faster Internet data transfer speeds (Bandwidth) in a country lead to greater Bitcoin price co-movements. However, a larger proportion of Internet users (Internet_users) and a faster hash rate of the block chain (ln(Hash_rate)) appear to weaken Bitcoin price co-movements with the US, possibly because of the presence of a greater pool of investors with more heterogeneous Bitcoin trading behaviour. Furthermore, as Bitcoin becomes easier to mine with the increased hash rates, the greater availability of Bitcoin in the exchange causes more volatile co-movements. These results are generally robust to using either the equally weighted R^2 or the transformed R^2 as the dependent variables (though slightly more volatile in the latter case).

[Insert Table 3 Here]

3.2.2. Cultural effects on Bitcoin exchange shutdowns

Table 4 reports some evidence on the determinants of Bitcoin exchange shutdowns, including the cultural variables. We find that stronger Bitcoin price co-movements (R^2 and $Tr(R^2)$) with the US Bitcoin exchange (which is regarded as more reliable) reduce the probability of Bitcoin exchange shutdowns in a country. Higher Bitcoin returns (Bit_R) and lower Bitcoin trading volumes (ln(Bit_V)) have the same impact, since the former are beneficial to investors whilst the latter results in an increase in speculative activities and greater potential losses which make a country more likely to shut down their Bitcoin exchanges to prevent those.

The coefficients on the cultural variables Tight and Indiv are now opposite to those reported in Table 3. The negative impact of Tight indicates that countries with a higher level of conscientiousness and social stability are less likely to shut down their Bitcoin exchanges, since this would generate much greater uncertainty than Bitcoin trading itself. Indiv also has a negative impact on the probability of Bitcoin exchange shutdowns, which suggests that countries with a more individualistic culture and more analytically skilled investors are more likely to keep their Bitcoin exchanges open. By contrast, a country with a collectivistic culture such as China had its cryptocurrency exchanges trading activities banned by its government from October 2017 (Shams, 2019).

We also find that greater trust increases the probability of Bitcoin exchange shutdowns. According to Guiso et al. (2008), less trusting individuals are less likely to invest in financial markets and buy stocks. Similarly, they might be less likely to purchase Bitcoins, which reduces speculative activities in the Bitcoin markets. Instead, higher trust is likely to encourage Bitcoin trading activities and thus increase the probability of Bitcoin exchange shutdowns as a result of excessive risk-taking activities. Risk-taking behaviour (Risk_taking) is found in fact to increase Bitcoin speculative activities and thus the probability of Bitcoin exchange shutdowns.

As for the impact of ln(GDP)and GDP_gvol, higher and more volatile economic growth appears to reduce the probability of Bitcoin exchange shutdowns, and so does proximity to the US Bitcoin exchanges with their tighter cyber security, as indicated by the effect of geographical distance between a country and the US (ln(Gendist)). Faster Internet speed (Bandwidth) and more Internet users (Internet_users) in a country tend to increase the probability of Bitcoin exchange shutdowns as a result of an increase in speculative activities that the government would like to prevent. However, an increase in the hash rate (ln(Hash_rate)) tends to reduce the likelihood of Bitcoin exchange shutdowns as Bitcoin investors benefit from less costly mining regardless of their trading behaviour. Finally, more mathematically skilled investors earn more investment income and manage their credit better (Cole et al., 2014, 2015), which reduces the probability of Bitcoin exchange shutdowns.

[Insert Table 4 Here]

4. Conclusions

This paper has examined the importance of cultural factors as determinants of the degree of co-movement between Bitcoin exchanges in 34 major countries around the world and the US. The approach taken is an extension of the market model of Morck et al. (2000) and Jin and Myers (2006) and is based on IV estimation. Unlike Eun et al. (2015), who had analysed the impact of cultural variables on within-country stock price co-movement, we provide evidence on their effects on cross-country Bitcoin exchange linkages.

In brief, we find that cryptocurrency markets in tighter, more individualistic, trustful and risk-taking societies are more likely to co-move with the US one. Moreover, countries with looser, collectivistic, trustful and risk-taking cultures are more likely to shut down their Bitcoin exchanges. These results confirm our theoretical priors.

Our analysis documents the importance of cultural variables as determinants of cross-country Bitcoin price co-movement and exchange shutdown decisions and casts doubt on the reliability of the findings of previous studies (e.g., Katsiampa, 2019; Shams, 2019) which are likely to have been affected by omitted variable bias.

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Table 1. Summary statistics

The following table shows the summary statistics of our variables. R^2 is our measure of Bitcoin price co-movement across countries using an expanded version of the market model by Morck et al. (2000) and Jin and Myers (2006). In Panel A, we show the data for our cryptocurrency, culture and control variables. We report their mean, median, 25th percentile (25th per), 75th percentile (75th per), standard deviation (Std.) and total number of observations (N) for each series. In Panel B, we show the countries and their corresponding bitcoin exchange quotes in our data set.

Panel A. Cryptocurrency, culture and control variables

	Mean	Median	25th per	75th per	Std.	N
R^2	0.90	0.93	0.88	0.93	0.07	10405
$Tr(R^2)$	2.36	2.60	2.04	2.60	0.64	10405
Bit_R	0.02	0.01	-0.04	0.07	0.14	10169
ln(Bit_V)	15.30	15.80	12.48	18.31	4.81	10229
Tight	6.26	6.30	4.40	7.20	2.05	7717
Indiv	55.48	60.00	38.00	74.00	22.25	10312
Trust	37.33	37.30	22.20	51.40	18.10	4726
Risk_taking	17.38	18.00	14.10	21.10	6.84	4726
Corrupt	3.85	1.20	0.30	6.00	5.42	9401
Govbur	12.98	13.20	10.40	15.30	4.17	9401
ln(GDP)	10.35	10.62	9.99	10.83	0.79	10383
GDP_gvol	0.01	0.01	0.01	0.02	0.01	10128
Bandwidth	357.87	93.20	53.60	183.90	1155.18	9111
Internet_users	75.16	80.60	65.00	87.00	17.08	9111
ln(Hash_rate)	36.24	37.91	30.25	40.06	5.05	10405
Religion	0.67	1	0	1	0.47	10405
ln(Gendist)	8.87	8.82	8.73	9.15	0.56	10405
Mathedu	4.75	4.6	4.4	5.2	0.83	9111
Shutdown	0.12	0	0	0	0.32	10405

Panel B. Countries

Country	Exchange quote
Australia	AUD/XBT
Austria	EUR/XBT
Belgium	EUR/XBT
Brazil	BRL/XBT
Canada	CAD/XBT
China	CNY/XBT
Denmark	DKK/XBT
Finland	EUR/XBT
France	EUR/XBT
Germany	EUR/XBT
Greece	EUR/XBT
Hong Kong	HKD/XBT
Indonesia	IDR/XBT
Ireland	EUR/XBT
Israel	ILS/XBT
Italy	EUR/XBT

Japan	JPY/XBT
Luxembourg	EUR/XBT
Mexico	MXN/XBT
Netherlands	EUR/XBT
New Zealand	NZD/XBT
Norway	NOK/XBT
Poland	PLN/XBT
Portugal	EUR/XBT
Republic of Korea	KRW/XBT
Russian Federation	RUB/XBT
Singapore	SGD/XBT
Spain	EUR/XBT
Sweden	SEK/XBT
Switzerland	CHF/XBT
Thailand	THB/XBT
Ukraine	UAH/XBT
United Kingdom	GBP/XBT
United States of America	USD/XBT

Table 2. Variable correlations

The following table presents the Pearson's correlation matrix for the variables in our sample. [a] stands for significance at the 1% level, [b] at the 5% significance level and [c] at the 10% level.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)
R^2 (a)	1[a]																		
Tr(R^2) (b)	0.95[a]	1[a]																	
Bit_R (c)	0	0	1[a]																
ln(Bit_V) (d)	0.16[a]	0.14[a]	-0.07[a]	1[a]															
Tight (e)	-0.12[a]	-0.14[a]	-0.01	0.18[a]	1[a]														
Indiv (f)	0.1[a]	0.13[a]	0.01	-0.23[a]	-0.42[a]	1[a]													
Trust (g)	0.23[a]	0.28[a]	0.01	0.01	0	0.39[a]	1[a]												
Risk_taking (h)	0.1[a]	0.07[a]	0	-0.28[a]	0.14	-0.28[a]	-0.51[a]	1[a]											
Corrupt (i)	-0.11[a]	-0.08[a]	-0.01	0.14[a]	-0.17[a]	-0.56[a]	-0.52[a]	0.34[a]	1[a]										
Govbur (j)	0.27[a]	0.3[a]	-0.01	-0.03[a]	-0.41[a]	0.13[a]	-0.06[a]	-0.33[a]	0.03[a]	1[a]									
ln(GDP) (k)	0.01	0	0.01	-0.28[a]	0.18[a]	0.62[a]	0.48[a]	-0.28[a]	-0.79[a]	0.07[a]	1[a]								
GDP_gvol (l)	-0.42[a]	-0.35[a]	0	-0.01	-0.4[a]	-0.24[a]	-0.25[a]	0.17[a]	0.56[a]	-0.26[a]	-0.55[a]	1[a]							
Internet_users (m)	-0.08[a]	-0.08[a]	0	-0.05[a]	0.1[a]	0.61	0.44[a]	-0.42[a]	-0.79[a]	-0.1[a]	0.84[a]	-0.41[a]	1[a]						
Bandwidth (n)	0.07[a]	0.04[a]	-0.01	0.09[a]	0.11[a]	-0.02[a]	0.15[a]	-0.02	-0.17[a]	-0.02[b]	0.31[a]	-0.12[a]	0.23[a]	1[a]					
ln(Hash_rate) (o)	0.08[a]	0.06[a]	-0.12[a]	0.76[a]	0.04[a]	-0.1[a]	-0.17[a]	0.04[a]	0.09[a]	-0.08[a]	-0.16[a]	-0.02	0.09[a]	0.12[a]	1[a]				
Religion (p)	0.28[a]	0.26[a]	0	-0.03[a]	-0.24[a]	0.48[a]	-0.21[a]	0.14[a]	-0.2[a]	0.21[a]	0.2[a]	-0.18[a]	0.22[a]	0.05[a]	0.03[a]	1[a]			
ln(Gendist) (q)	-0.28[a]	-0.45[a]	0	0.09[a]	0.13[a]	-0.35[a]	0.42[a]	-0.1[a]	0.05[a]	-0.23[a]	-0.16[a]	0.16[a]	-0.22[a]	0.01	-0.01	-0.4[a]	1[a]		
Mathedu (r)	0.02[b]	0.05[a]	0	0.03[a]	0.25[a]	0.26[a]	0.69[a]	-0.28[a]	-0.6[a]	-0.28[a]	0.5[a]	-0.33[a]	0.52[a]	0.08[a]	0.04[a]	-0.17[a]	0.09[a]	1[a]	
Shutdown (s)	-0.25[a]	-0.19[a]	0.01	-0.17[a]	0.02	-0.14[a]	0.46[a]	-0.05[a]	0.01	-0.1	-0.08[a]	0.01	-0.11[a]	0.03[a]	-0.21[a]	-0.3[a]	0.23[a]	0.11[a]	1[a]

Table 3. Cultural analysis of Bitcoin co-movements

The following table shows the regressions using equally weighted R^2 (regressions (1) and (2)) transformed R^2 ($Tr(R^2) = \ln(\frac{R^2}{1-R^2})$) (regressions (3) and (4)) as dependent variables to analyze the cultural effects on Bitcoin's co-movements across the countries using the US Bitcoin exchange as a benchmark. We use OLS regressions in (1) and (3) and instrumental variable regressions in (2) and (4). We report the F-test values for the OLS regressions in (1) and (2). Then we report the p-values for the instrument relevance and Wu-Hausman endogeneity tests, and also the Wald test for our instrumental variable regressions in (2) and (4). For all regressions, we report the Adjusted R^2 as for our goodness-of-fit measures. N is the total number of observations reflecting missing values in our regressions. *** stands for significance at the 1% level, ** at the 5% level and * at the 10% level.

	(1)	(2)	(3)	(4)
Intercept	**1.327*** (56.687)**	**1.299*** (30.463)**	**6.254*** (29.924)**	**5.067*** (13.709)**
Bit_R	0.005 (0.886)	0.007 (1.118)	0.036 (0.759)	0.023 (0.412)
ln(Bit_V)	**0.005*** (19.186)**	**0.006*** (8.156)**	**0.054*** (21.241)**	**0.079*** (11.812)**
Tight	**0.003*** (3.94)**	**0.011** (2.222)**	**0.026*** (3.848)**	-0.02 (-0.461)
Indiv	**0.002*** (19.849)**	**0.002*** (4.88)**	**0.016*** (21.693)**	**0.012*** (2.847)**
Trust	**0.003*** (46.723)**	**0.002*** (10.908)**	**0.026*** (51.619)**	**0.026*** (14.395)**
Risk_taking	**0.005*** (31.955)**	**0.004*** (6.619)**	**0.041*** (29.545)**	**0.05*** (8.725)**
ln(GDP)	**0.023*** (7.864)**	**0.025*** (6.786)**	**0.118*** (4.587)**	**0.18*** (5.559)**
GDP_gvol	**-1.745*** (-7.677)**	-0.316 (-0.553)	**-18.36*** (-9.046)**	**-19.69*** (-3.968)**
ln(Gendist)	**-0.074*** (-21.516)**	**-0.085*** (-12.033)**	**-0.562*** (-18.309)**	**-0.485*** (-7.925)**
Bandwidth	0.00003 (13.451)	**0.00005*** (4.913)**	**0.00019*** (10.611)**	**0.00014* (1.78)**
Internet_users	**-0.004*** (-24.482)**	**-0.004*** (-16.678)**	**-0.034*** (-26.312)**	**-0.033*** (-16.812)**
ln(Hash_rate)	**-0.002*** (-8.641)**	**-0.002*** (-4.007)**	**-0.023*** (-9.794)**	**-0.031*** (-7.085)**
Wald test		**284.8*** **		**322.3*** **

F-test	**485.5*** **		**548*** **	
Adjusted R^2	0.62	0.62	0.65	0.67
Instrument Relevance (P-value): Trust		0		0
Instrument Relevance (P-value): Tight		0		0
Instrument Relevance (P-value): Indiv		0		0
Wu-Hausman (P-value)		0.101		0.179
N	3538	3321	3538	3321

Table 4. Cultural analysis of Bitcoin exchange shutdowns

The following table reports the results from IV logistic regressions to analyze the impact of the cultural variables on Bitcoin shutdowns. The dependent variable is shutdown in both cases. We use two types of comovement regressors, R^2 and $Tr(R^2)$ in regressions (1) and (2), respectively. We report the p-values for the instrument relevance and Wu-Hausman endogeneity tests, and also the Wald test and R^2 as for our goodness-of-fit measures. N is the total number of observations reflecting missing values in our regressions. *** stands for significance at the 1% level, ** at the 5% level and * at the 10% level.

	(1)	(2)
Intercept	**2.952***** **(24.866)**	**1.324***** **(14.185)**
R^2	**-2.295***** **(-29.94)**	
$Tr(R^2)$		**-0.229***** **(-23.204)**
Bit_R	**-0.037**** **(-2.366)**	**-0.04**** **(-2.417)**
ln(Bit_V)	**0.012***** **(13.836)**	**0.012***** **(12.604)**
Tight	**-0.085***** **(-32.124)**	**-0.084***** **(-31.738)**
Indiv	**-0.004***** **(-16.575)**	**-0.005***** **(-16.666)**
Trust	**0.025***** **(61.506)**	**0.025***** **(51.149)**
Risk_taking	**0.028***** **(34.968)**	**0.026***** **(29.549)**
ln(GDP)	**-0.499***** **(-58.836)**	**-0.524***** **(-55.93)**
GDP_gvol	**-38.69***** **(-54.979)**	**-38.82***** **(-52.569)**
ln(Gendist)	**0.638***** **(51.568)**	**0.68***** **(54.046)**
Bandwidth	**0.0001***** **(18.058)**	**0.00008***** **(13.721)**
Internet_users	**0.001**** **(2.392)**	**0.002**** **(3.433)**
ln(Hash_rate)	**-0.02***** **(-21.805)**	**-0.02***** **(-20.551)**

Mathedu	**-0.233***** **(-32.414)**	**-0.24***** **(-30.4)**
χ^2	**1512.72*****	**1690.76*****
R^2	0.28	0.09
Instrument Relevance (P-value): Trust	0	0
Instrument Relevance (P-value): Tight	0	0
Instrument Relevance (P-value): Indiv	0	0
Wu-Hausman (P-value)	1	1
N	3538	3538